

REMARKS/ARGUMENTS

This Amendment accompanies a Request for Continued Examination (RCE) and addresses the issues presented in the Official Action of May 11, 2010, a Final Rejection.

The claims have been amended in order to more particularly point out and distinctly claim that which applicants regard as their invention and to advance examination generally.

An important feature of the present invention is its applicability to metal particles manufactured by an electrochemical reduction process, namely by electrochemical reduction in a fused salt. This means that the salt itself is a major source of contamination and therefore that the purification process needs to be appropriate for the removal of the fused salt from the metal particles.

Claim 31 is amended to specify that the metal particles are manufactured by an electrochemical reduction process by electrolysis in a fused salt, and that the contaminating impurities comprise the fused salt. Support for these amendments is found at page 1, lines 11 and 12 (page 7, lines 1 to 3 and page 11, lines 28-30 also specify that the electrochemical reduction process may be the process described in WO 99/64638, mentioned at page 1, line 9), page 3, line 11 which mentions that a salt inclusions are particularly detrimental, and page 4, line 7 which mentions that the contaminating impurities may comprise salts from electrolyte.

These amendments also serve to further distinguish the claims now being examined from the prior art documents applied in the Final Rejection.

All of the rejections in the Office Action of May 11, 2010 are based on newly cited US 6,589,311 of Han et al as the primary reference. Han describes a method for making a high-melting-point metal powder, particularly of Ta or Ru. The method involves feeding the metal particles into a plasma into which hydrogen gas has been introduced (see the Abstract and column 3 lines 56 to 58). Column 5, lines 19 to 22 explains that the effect of the hydrogen is to improve the evaporation of impurities and to reduce the oxygen content of the high-melting metal.

Use of the very high temperatures of a plasma, such as the 5,000-10,000K mentioned in the Han prior art, would lead to extremely rapid volatilization of the fused salt and would be likely to destroy, or break up, the metal particles. While the present application does mention the

use of a plasma, the applicant now considers a plasma to be inappropriate, and has excluded plasma from claim 31.

The Examiner has previously cited GB 2121441 of Down, which also described a method for purifying metal particles in a plasma. In applicants' response of 14 July 2009 they explained why plasma processing is inappropriate in the present invention and the Examiner has not subsequently referred to Down. As explained in that earlier response, a plasma is much too hot for processing most metals, is too viscous, and the temperature across a plasma can vary excessively. The same defects in (withdrawn) Down apply to Han.

Column 5 lines 13 to 23 of Han teach the use of thermal plasma, preferably radio frequency (RF) thermal plasma. Line 58 of column 5 describes the raw material powder being fed into the plasma high-temperature zone having a temperature between 5000 and 10000K. The present application is directed to the purification and spheroidization of metal powders prepared by electro-decomposition in fused-salt electrolytes. A preferred metal for production by this method is Ti and Ti alloys (see for example page 10 of the application), although many other metals can be produced in the same way, and a significant impurity in the metal products of electro-decomposition is the salt in which electro-decomposition is performed, which is typically calcium chloride. If a metal powder containing calcium chloride, typically within inclusions within the powder, is rapidly heated to between 5000 and 10,000K, the fused salt will immediately boil and the particle is likely to explode. The boiling point of calcium chloride is 1935°C (2208K).

If the metal particles are Ti or a Ti alloy, then on exposure to the plasma at 5000 to 10,000K, the metal particles themselves will vaporize. The boiling point of Ti is 3287°C (3560K).

Column 6 lines 8 to 11 of Han explain that oxides and low-melting impurities contained in the Ta or Ru powder evaporate in the plasma because their vapor pressures are higher than those of Ta and Ru. Plasma processing as described by Han is only suitable for metals such as Ta and Ru which have extremely high boiling points and which do not contain inclusions of contaminants such as calcium chloride that have very much lower boiling points.

Further, Han teaches including hydrogen gas in the plasma, in order to enhance the removal of oxide impurities from the Ta or Ru. The presence of hydrogen is completely

unsuitable and unnecessary for processing the products of electro-decomposition, which have extremely low oxygen content. Removal of oxygen is a primary purpose of the electro-decomposition process. After electro-decomposition it is necessary to remove other types of impurities, such as calcium chloride, and not oxygen or oxides. Any oxygen has already been removed. In addition, for titanium, the introduction of hydrogen is particularly disadvantageous. This would result in the formation of titanium hydride or at the very least embrittled titanium metal. Titanium embrittlement due to the presence of hydrogen is a well known problem in the use of titanium and titanium alloys, and it very important that it should be avoided.

The Examiner argues that Han's heat source is a thermal plasma which 'meets the limitation of a gas flame' in the claims in the application. This is simply incorrect. In a plasma, a certain portion of the particles are ionized (see for example the Wikipedia entry for 'plasma'). A gas flame simply involves a chemical reaction between a gas and oxygen, and does not involve any ionization of particles. Plasmas such as Han's plasma differ very significantly from gas flames, in part because they are very much hotter. A typical flame burns at between 1000 and 2000°C, and even an oxyacetylene torch only achieves 3000°C. Han's plasma is between 5000 and 10,000K.

The examiner will note that applicants' critique of the applied prior art points of distinction are reflected in the amended claims presented above.

Please examine the claims as above amended taking into account the documents of record as of May 11, 2010, the mailing date of the most recent Official Action.

The Commissioner is hereby authorized to charge any deficiency, or credit any overpayment, in the fee(s) filed, or asserted to be filed, or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 14-1140.

WARD-CLOSE et al
Appl. No. 10/529,234
November 5, 2010

Respectfully submitted,

NIXON & VANDERHYE P.C.

By: /Arthur R. Crawford/
Arthur R. Crawford
Reg. No. 25,327

ARC:caw
901 North Glebe Road, 11th Floor
Arlington, VA 22203-1808
Telephone: (703) 816-4000
Facsimile: (703) 816-4100